REMARKS

Claims 1–3, 6–13, 19–22 and 29–34 are pending and stand rejected. New claims 35–46 are added by the instant amendment and claims 1 and 19 are amended.

Claims 1, 2, 4-9, 11, 13-17, 19, 20, 22 and 24-27 stand rejected over Zhao et al. as anticipated with Section 102(e) rejections, and further for obviousness Section 103 rejections of the remaining claims. While Zhao et al. relates generally to signal decomposition (i.e., wavelets) for fault detection in equipment, in fact Zhao teaches two distinct methods, neither of which anticipate or make obvious the pending claims of the present invention.

According to a first method, a signal from monitored equipment is decomposed (e.g., wavelet features are extracted, Zhao col. 5 line 1) so as to perform a <u>classification</u> of the signal as matching normal or matching one of several fault patterns. Zhao refers to "signal templates" which are basically idealized sets of features representative of either normal or a particular fault, and Zhao teaches the use of correlation amplitude as a means of matching the template to the features of the current observation. Discriminant analysis is also taught in Zhao as a way of determining in n-dimensional feature space what signal template a current observation is closest to (Zhao col 5, lines 20-29). This first method teaches only classification. There is no signal modeling or estimation, and further the means of classification are conventional methods such as correlation and nearest neighbor. This method as taught by Zhao also has nothing to do with residuals.

According to a second method taught in Zhao, a signal model is used to provide a "nominal response" for the system of interest, which is differenced with the current observation to provide <u>residuals</u>. While Zhao enumerates several ways of providing this "nominal response", importantly all of these merely provide a fixed, idealized pattern against which the monitored signal compared to yield residuals. Thus, the nominal response can be a "statistical average" of normal operations demodulated segments; or this so-called signal

model can be the "signal template of wavelet coefficients" from normal operations (Zhao col 5, lines 37-45). Zhao's mention of autoregression models and lumped parameter models (Zhao col. 5, lines 45-57) merely represent just fixed models in the best possible interpretation, but even this is not clear since Zhao mentions them only in passing and does not teach or disclose how these techniques would be used in the context of any features extracted from signals. At best, the mention of these techniques is confusing. In any case, none of these techniques anticipates similarity-based modeling to generate estimates for creating feature residuals, as is claimed in the present invention.

In contrast to both of these teachings, and any teaching in Zhao at all, the present invention utilizes similarity-based modeling (e.g., equation 5, etc., of the application) to provide heretofore unexpected modeling efficacy of complex signal features from vibration, acoustic, electric current and the like sensor signals. According to similarity-based modeling, estimates of a system are generated using a similarity operation, and learned observations are also compared to themselves for similarity (e.g., equation 17). While similarity-based modeling has been used successfully as a multivariate approach to related process sensor signals (temperatures, pressures, flows, and other distinct but physically related parameters) it has been unexpected that "features" from a complex signal would be model-able by the same technique, since features are not so directly interrelated. It would be far from obvious that features of a single complex signal could be modeled successfully with such an empirical technique. Moreover, similarity-based modeling has unique advantages over other modeling techniques, such as robustness for anomaly detection, and in contrast to any modeling technique typically used for fault detection is a nonparametric, adaptive technique. As can be seen from Equation 5 of the present application, the currently monitored input is part of the calculation of the estimate, and from equation 7 it can be seen that the currently monitored input is also a means of deriving weights for learned observations. Put another way, the

"model" is nonparametric in that parameters are not determined and fixed up front as they are in standard regressions, but are re-derived with each new observation. This is wholly different from anything heretofore applied to features of a complex signal.

Claim 1 has been amended to incorporate limitations analogous to claims 4 and 5, which is not taught by Zhao et al. <u>The correlation techniques taught in Zhao do not take into account the expected range of a given component in determining the similarity of snapshots.</u> Claims 2, 3, and 6-10 depend from claim 1, which is not anticipated by Zhao, and are furthermore not obvious from combination of Zhao with any of the other art cited by the Examiner.

Claim 11 is not anticipated by Zhao et al., because Zhao does not teach generating estimates of the component values using similarity-based modeling. For that matter, Zhao does not teach the use of any kind of nonparametric model (as described above). Dependent claim 12 is not obvious from a combination of Zhao and other art since Zhao does not teach the claimed modeling approach.

Claim 13, which depends from claim 11, is not anticipated by Zhao not only because Zhao does not teach the use of similarity-based modeling, but also because Zhao does not teach generating estimates using a similarity operator that normalizes similarity with an expected range for values being compared. At col 5, line 23 cited by the Examiner, Zhao merely teaches measuring how close a sensor signal segment is to a template, but does not mention any determination of what a normal *range* for a segment might be.

Claim 19 has been amended to include the limitation of claim 23 which the Examiner indicated as patentable subject matter, and claim 23 has been cancelled. Dependent claims 20-22 should now also be in condition for allowance as depending from amended claim 19.

Claim 29 has been amended to further clarify the nature of step c. As now claimed, this is not taught in Zhao, nor is it made obvious by a combination of Zhao with any of the

references cited by the Examiner. The comparison step c is different from a correlation as taught in Zhao because it is a function of a difference of the corresponding components and their expected range. This is also different from the template comparison techniques described in Zhao in col. 5, lines 37-57. Those teachings by Zhao do not provide for modification of the difference from the template based on an expected range.

Claims depending from Claim 29 should be patentable as depending from patentable claim 29.

The application is considered in good and proper form for allowance, and the Examiner is respectfully requested to pass this application to issue. If, in the opinion of the Examiner, a telephone conference would expedite the prosecution of the subject application, the Examiner is invited to call the undersigned attorney.

Respectfully submitted,

Date: 2-4-04

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